Fill Quality Guidelines for Lakefilling in Ontario

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Protecting our environment. Ontario

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Executive Summary

The purpose

The purpose of Ontario's new Fill Quality Guidelines is to protect the quality of the sediment and water in areas adjacent to lakefilling activities. The Fill Quality Guidelines provide guidance with respect to the quality of the fill which may be used in lakefill projects. The Fill Quality Guidelines, together with the Provincial Sediment Quality Guidelines provide enhanced protection of the aquatic environment.

Lakefilling

Lakefilling is the practice of creating new land by placing rubble, stones, concrete, brick and loose earth into shallow areas in lakes and rivers.

Some of the benefits of lakefilling projects include the creation of land for parks, marinas and wildlife preserves as well as protection of shorelines from erosion or floods.

Monitoring of some existing sites suggests that in some cases the fill used has degraded the quality of the water and sediment and has had deleterious effects on aquatic organisms.

Existing Regulations

Currently, most major lakefilling projects proposed by ministries, municipalities or conservation authorities become subject to the Environmental Assessment Act since they are part of a larger project, such as a waterfront park, which is subject to the Act.

Private lakefilling proposals may also be designated under the Environmental Assessment Act, if part of a project or the whole project - a marina and waterfront recreation centre, for example - is significant.

In addition, it is the responsibility of proponents of lakefilling activities to be aware of and consider other provincial and federal legislation and policies, such as the province's Lakes and Rivers Improvement Act and Public Lands Act administered by the Ministry of Natural Resources (MNR) and the federal Fisheries Act and the Navigable Waters Protection Act.

Prior to 1992, the quality of fill which was to be placed directly into the water was evaluated against criteria outlined in Ontario's Open Water Disposal Guidelines for sediment. These guidelines were developed to determine whether or not dredged material was suitable for disposal in open water, but were also used to evaluate potential fill. Beginning in 1992 with the adoption of the Fill Quality Guidelines on an interim basis, the Fill Quality Guidelines for Unconfined Fill replaced the Open Water Disposal Guidelines.

The Fill Quality Guidelines

Fill which may be used for lakefilling projects is divided into two categories - Confined Fill and Unconfined Fill:

- **Confined fill** may be used for lakefilling projects provided it is placed within the confines of a structure, such as a dyke, which is capable of withstanding the waves of a-once-in-100-years storm. The intent is to prevent the fill from coming into contact with the open water and, in the event of a storm or high waves, being washed away.
- **Unconfined fill** which may be placed directly into open water. To be categorized as Unconfined Fill, material must first pass a set of stringent tests including:
  - bulk chemical tests for 8 metals and organic compounds including polychlorinated biphenyls (PCBs), arsenic, cadmium, chromium, copper, lead, mercury, nickel, zinc, total organic carbon and total phosphorus.
  - the Receiving Water Simulation Test which determines whether or not organic compounds such as PCBs leach out from the fill.
  - further tests which the MOE may request on a case by case basis. The tests may include additional chemical analyses for nutrients, other metals and organic compounds listed in the Provincial Sediment Quality Guidelines.

Unconfined Fill must meet the Lowest Effect Level of the Provincial Sediment Quality Guidelines for organic parameters and either the Lowest Effect Level or the background level of the sediment for metals. The background level is the quality of the sediment before it was affected by human activity. The Lowest Effect Level is the level of contamination in the sediment at which testing shows there is no toxic effect on the majority of sediment-dwelling organisms.

In addition, the fill must be free of substances which could bioaccumulate in organisms or which could form objectionable deposits - such as scum - or degrade the potential of the water for recreation or as a habitat for aquatic life.

Under the Fill Quality Guidelines for Lakefilling in Ontario, fill that fails the tests for Unconfined Fill may qualify as Confined Fill if it meets the requirements for Confined Fill. Material that fails the requirements for Confined Fill may not be used for lakefilling and needs to be managed in accordance with other policies or applicable procedures developed to address the movement or disposal of excess soil, such as Regulation 347(Waste Management) of the Environmental Protection Act.

While the lakefilling project is being built all reasonable measures need to be taken to minimize turbidity and to reduce the loss of fill. Precautions may include placing fill only during calm periods and/or protecting all exposed areas of the lakefill project from severe storms by dykes and enclosures to prevent erosion.

Foreword

The guidelines provided in this document were developed for evaluating the suitability of fill material for lakefilling. They are designed to protect the aquatic environment from both the physical effects of, and contaminants associated with lakefill materials. The guidelines incorporate features of the Provincial Sediment Quality Guidelines to ensure protection of sediments and the Provincial Water Quality Objectives to ensure protection of water quality and water uses. Some provisions in this document relating to the suitability of fill material for lakefilling, specifically the use of the Confined Fill Guidelines, contain references to material in the Ministry publication *Guideline for Use at Contaminated Sites in Ontario* (OMOE 1997).

In addition to the protection of water and sediment quality, many other issues such as habitat alteration, alteration of current patterns, and siting and design, need to be addressed before a lakefill is built.

Although these Guidelines may assist proponents and regulators in determining whether or not a proposal will have unacceptable environmental effects, they do not exempt projects from current evaluation procedures or approval requirements under legislation administered by this Ministry, or by other Ministries or agencies. Proponents are responsible for complying with all appropriate policies and/or laws, both federal and provincial.

1. Introduction

Lakefilling refers to the placement of solid material (e.g., loose earth, rubble, broken concrete) in or abutting a waterbody (lakes and rivers) to create structures for flood and erosion control (e.g., shoreline protection or stabilization works), land creation (e.g., waterfront parks and recreational boating facilities) and confined disposal facilities for dredged material.

1.1 Lakefilling in Ontario - Background

Most of the large lakefills for the purpose of land creation have been centered in the western basin of Lake Ontario, especially the area adjacent to the Toronto waterfront. The Toronto Harbour Commission, under Federal charter, has been using this technique to develop the Toronto waterfront since 1911. Since the 1950's, the Commission has been involved in the construction of the Eastern Headland (also known as the Leslie Street Spit) which is the largest lakefill structure in Lake Ontario.

During the late 1960s and 1970s, the conservation authorities bordering western Lake Ontario and other government agencies (e.g., municipalities, Government of Ontario) proposed shoreline plans which included varying degrees of land creation through lakefilling.

Creation of new land resources through filling in the littoral (shallow, near-shore) zone can be an appealing concept for several reasons. With lakefront property commanding a premium price, the creation of new land by lakefilling is attractive, particularly in the heavily populated western basin of Lake Ontario. In many cases, lakefills provide recreational opportunities that would otherwise not exist and could not be provided through the purchase of existing shoreline properties.

Concerns over the environmental implications of lakefilling that have been consistently raised over many years have recently heightened across western Lake Ontario, particularly in the Greater Toronto area.

The impact on the aquatic environment of building lakefills using the present methodology has not been adequately assessed. However, monitoring of existing sites has, in some cases, indicated degraded soil, water and sediment quality, and disruption of aquatic communities in the vicinity of lakefill structures.

The main area of concern has centered around the quality of the material that has been used in lakefills. Monitoring of fill quality has indicated that material with the potential to impair water and sediment quality has entered lakefills.

1.2 A Fill Quality Program

The **Guidelines** which follow have been developed to provide environmental protection from the loss of fill and associated contaminants during lakefilling. They are meant to ensure that lakefilling does not significantly impair water quality, aquatic habitat, and adjacent uses from the loss of fill.

Criteria to address aquatic environmental concerns have been developed such that the quality of fill and method of placement will ensure meeting:

- The MOE water quality management goal: "To ensure that the surface waters of the province are of a quality which is satisfactory for aquatic life and recreation" (OMOEE, 1994)
- The Provincial Sediment Quality Guidelines: to protect organisms that are directly impacted by contaminated sediment, namely the sediment-dwelling (benthic) species; and to protect against biomagnification of contaminants through the food chain from sediment contaminant sources.

In addition to the protection of water and sediment quality, many other issues must be addressed before a lakefill can be built. All lakefilling projects must meet requirements under federal and/or provincial legislation, such as the Fisheries Act and the Lakes and Rivers Improvement Act. A listing of the various pieces of legislation that may affect the siting, design and construction of a lakefill is provided in Appendix A.

2. Application Considerations

The Lakefill Guidelines apply only to materials placed in water up to the high water mark of the existing shoreline. They do not apply to materials placed landwards from the edge of the existing shoreline.

2.1 Types of Projects

The fill quality guidelines apply to all new and on-going lakefill projects including:

- shoreline stabilization projects
- construction of piers, groynes, docks, and causeways
- construction of breakwaters and Confined Disposal Facility (CDF) perimeter walls/structures
- large-scale projects for recreational purposes (e.g., Bluffers Park)
- beach creation

Lakefill fill quality guidelines do not apply to:

- contaminated material placed within a CDF structure such as dredge spoils. These may be granted approval under Part V of the Environmental Protection Act and conditions of disposal will be regulated through Certificates of Approval since these structures are designed to contain specific materials for disposal

- material placed on shorelands above the high water mark. (Such materials should be adequately stabilized or protected to prevent erosion of material into the watercourse).
- filling behind impermeable barriers such as concrete or sheetpile revetment walls (subject to appropriate treatment of decant water).
- projects designated as emergency shoreline works (designated by a MOE Regional Director), e.g., repairs and maintenance to flood and beach protection works.

2.2 Project Specific Application Procedures

a) Large Scale Projects Subject to the Environmental Assessment (E.A.) Act: All projects subject to the Environmental Assessment (E.A.) Act (either Full E.A. or Class E.A.) would typically proceed through the Environmental Assessment process and the Guidelines would be applied through conditions written into the Terms and Conditions of Approval.

Fill quality guidelines and other design and construction mitigation measures would be addressed in the E.A. process. This would require the proponent to provide details in the initial E. A. document of how lakefilling would be done and what environmental safeguards would be followed. These would then become part of the conditions of approval of the undertaking.

In the case of Class E.A.s, this information would be contained in the Environmental Study Report of individual projects. It is expected that when Class E.A.s having lakefilling components come up for review they will specifically address and comply with the Fill Quality Guidelines.

b) Large-scale Projects not subject to the E.A. Act: Proponents of projects not subject to the E.A. Process are still subject to the guidelines or other policies related to environmental protection regarding lakefilling activities and should provide to the MOE Regional Director all information on fill quality and construction techniques (i.e. engineering design) that would normally have been required for E.A. approval.

c) Federal Projects (e.g., CDFs, Small Craft Harbours): The Federal government, through agencies such as Environment Canada, has been willing to adopt Provincial guidelines/policies on federal projects.

d) Small-scale Provincial and Private: most small-scale projects would require a Ministry of Natural Resources (MNR) Work Permit. The MNR work permit system is operated under the Public Lands Act and provides that no person shall dredge or fill a shoreland or work on any public land without a work permit. Projects that could alter or destroy fish habitat would fall under the federal Fisheries Act and may also require approval from Department of Fisheries and Oceans.

Proponents should be aware that any project needing approval under federal legislation (e.g., Navigable Waters Protection Act), or being undertaken on federal land or with federal monies, may trigger the Canadian Environmental Assessment Act (CEAA), and may be required to meet the requirements of the CEAA process.

MOE comments on projects under the MNR permitting system. This is currently done on an informal basis, but allows MOE Districts and/or Regions to review and comment on all small scale lakefilling projects. The proponent initially applies for approval under the Public Lands Act. The proponent is then instructed to contact the MOE District Office. Currently, most of the projects submitted for approval have a perimeter constructed of clean material (granular, rock, sheet piles) prior to backfilling with fine material. For larger projects, the proponent often identifies the source of the backfill material "borrow area".

3. Fill Placement

3.1 General Conditions

- filling should only take place during the defined calm period (June to August or MNR Hindcast Method) in those areas subject to storm/wave damage.
- exposed fill face should not be more than a specified length, usually 15 metres.
- in instances where Confined Fill will be used in a lakefill, the outer structure must be constructed of material meeting the Unconfined Fill criteria (e.g., quarried stone, concrete rubble, or other similarly inert material). The outer structure must be completed to provide full protection before commencing placement of material classified as Confined Fill.

3.2 Siting and Design Considerations

The following general provisions must be given full consideration during the siting and design phase to ensure a lakefill will not affect water uses.

Lakefills:

- should be located so as not to affect water intakes or outfalls.
- should be located so as not to affect navigation routes or shipping channels.
- should be located such that erosion of material will not affect the structural or functional integrity of onshore and offshore discharges or intakes or other sensitive water uses.
- should be designed to:

minimize the creation of embayment areas; minimize the amount of semi-protected shoreline created; maximize the flushing of embayments reducing the deposition of sediments; and to avoid direct input of storm sewers or other discharges into embayments created.

4. Environmental Criteria

4.1 General

During construction of a lakefill, major aquatic effects are associated with loss of fill material along with the contaminants associated with the fill. These effects may be chemical or physical.

Chemical effects are associated with changes to water and sediment quality. Physical effects are two-fold: the effects of suspended sediment on water quality, specifically turbidity; and, the effects of deposited sediment on aquatic habitat.

Environmental criteria outlined here are designed to determine the acceptability of fill and on-site placement of lakefill materials. These criteria identify two categories of acceptable fill: Confined and Unconfined Fill. The screening system is outlined in Figures 1 to 3.

- **Confined fill**: material that meets the initial screening criteria only. Material that meets the Confined Fill criteria may only be used within the confining structure of a lakefill. Such material may not be used where it comes, or may potentially come, into contact with open water.
- **Unconfined fill:** material that meets the initial screening criteria as well as additional more restrictive criteria. Since Unconfined fill can be used in construction of the confining structure, and as such will come into direct contact with open water, more restrictive criteria are imposed on this classification.

If lakefilling material meets the criteria for Confined Fill, the proponent at this point has a choice of following the conditions for placement of Confined Fill, or proceeding to determine if the material meets the criteria for acceptability as Unconfined Fill.

4.2 General Conditions Governing Fill Evaluation

a) Certain types of material, provided they meet the criteria in section 4.3, are considered acceptable for lakefilling. These include quarried rock, clean brick, concrete rubble, sand, gravel and excavated soils. To be acceptable for lakefilling the material must not contain other construction debris or putrescible material, must be free of visible staining, and be free of odour.

b) Materials such as asphalt and construction debris, chimney brick or painted brick, slag, fly ash and other industrial/ commercial wastes and/or by-products are not considered acceptable in a lakefill. Some materials may be considered for use where the proponent is able to demonstrate, through rigorous scientific studies funded by the proponent, that the material will not adversely affect the aquatic environment.

c) Classification criteria for fill have been developed in conjunction with the *Guideline for Use at Contaminated Sites in Ontario (1997)*. A single series of analytical tests is required for material classification. Material will be tested by bulk sediment analysis and results reported on a dry weight basis (see *Sampling and Analytical Protocols (1996)* in the *Guideline for Use at Contaminated Sites in Ontario (OMOE 1997)* for additional sampling information). According to the results of these tests, material that meets the Confined Fill criteria in Tables B-1 and B-2 (Appendix B of the Fill Quality Guidelines) can then be placed in a lakefill. No additional testing is required at this stage if the material is destined only for use as Confined Fill.

d) Material that passes additional tests as outlined in this document can qualify as Unconfined Fill and can be placed in contact with open water. In order for material to be classified as Unconfined Fill, it must pass the Unconfined Fill criteria, as well as a Receiving Water Simulation test.

Additional information on analytical methods and site sampling is detailed in the *Sampling and Analytical Protocols* (1996) referred to above. As a minimum, analysis will include all parameters identified in Table B-3 (Mandatory Parameter List for Unconfined Fill). Additional parameters may be required by MOE regional offices on a case-by-case basis, depending on site history.

4.3 Fill Quality Evaluation

Suitability of materials for use in a lakefill structure is also based upon chemical evaluation. A proponent wishing to have potential fill material considered for use as either Confined Fill or Unconfined Fill should ensure that the parameters required for evaluation are included in the initial chemical analysis, since the Mandatory Parameter Lists for the Confined Fill and Unconfined Fill are not identical.

Rock, clean brick and concrete rubble do not typically require testing, except where there may be a concern regarding the origin of the material. Brick or concrete rubble that originates from an installation where it may have been contaminated, such as an industrial site, needs to be tested for those parameters that a review of the site history has indicated may be of concern. Where there is visible staining by oils or other substances, the material is not suitable for lakefilling.

In the case of quarried rock, some areas of the province have naturally higher levels of some metals. Where locally high occurrences of some metals may be of concern, the rock should be subjected to a Receiving Water Simulation test.

4.3.1 Confined Fill Material Criteria

Confined Fill criteria are primarily based on the protection of the terrestrial environment. Material for use as Confined Fill must meet the MOE's Confined Fill criteria as defined in Tables B-1 and B-2 (Appendix B).

The Confined Fill criteria are used for screening potential fill materials. Fill materials from any source can be considered for use in a lakefill, providing that they meet the appropriate narrative and numeric criteria in this document.

Appendix B provides the mandatory parameter list for use in evaluating the suitability of fill for use in a lakefill. Material of residential or parkland origin will generally require less extensive testing than material of commercial or industrial origin.

- All material, regardless of origin is to be tested for those parameters listed in Table B-1 of Appendix B.
- For material from any site where a history of the site indicates uses other than agricultural or residential, chemical analysis for the additional parameters listed in Table B-2 will be required. Application can be made to reduce this parameter list if the proponent can satisfactorily demonstrate that certain compounds have no history of use at the site.

Initial acceptability of the lakefill material is determined on the basis of:

- The material meets the Confined Fill Guidelines in Appendix B.
- Initial evaluation of fill material is conducted by comparing the chemical concentrations of the material to the parameter values in the Confined Fill Guidelines (Appendix B). Material is not suitable for use in a lakefill if:
  - the result from a single sample, or if replicate samples are taken, the mean of replicate samples, is numerically greater than the criterion for a particular chemical parameter.
- Where it is feasible to segregate material of varying quality from a particular site, the following shall apply:
  - the soil between the sample site that failed, and the next sample site which passed the criterion is considered as having failed the criterion for that chemical parameter.

Since additional sampling between sampling sites will better define the area of material suitable for lakefilling, it is often in the interest of the proponent to undertake more detailed sampling.

Fill material that passes these criteria qualifies as **Confined Fill** and can be used for lakefilling if the following conditions are met:

- Confined fill is placed within a confining structure such that there will be no loss of material to the surrounding aquatic environment.

- During the active filling phase, the confining structure is designed to withstand the most significant wave that could occur in storms over a 25-year period. The placement of material classified as Confined Fill can occur only after such a confining structure is completed.
- At the end of the filling season or upon completion of the project, the confining structure is protected to the estimated 100-year storm significant wave prior to the end of the calm period[1] during which confined fill was first deposited.

4.3.2 Unconfined Fill Material Criteria

In order to qualify as **Unconfined Fill,** (i.e., material suitable for use in contact with open water), material that has passed the Confined Fill criteria must not impair sediment quality as determined by the Provincial Sediment Quality Guidelines (PSQGs)(Persaud *et al.* 1993).

Evaluation of fill material is based upon comparison with the Unconfined Fill Guidelines listed in Tables B-3 and B-4 of Appendix B. A mandatory list of parameters requiring analysis is given in Table B-3. Other parameters listed in Table B-4 of Appendix B may be required on a case-by-case basis after review of the history of the site where the material originates.

In order to qualify as Unconfined Fill, the material must first meet the Site-Specific Suitability chemical criteria discussed below and outlined in Figures 2 and 3. Candidate material will be tested by bulk chemical analysis and results reported on a dry weight basis (OMOE 1983) or approved equivalent analytical procedures).

Site-Specific Suitability of Fill

Organic Compounds

If sediment quality in the vicinity of the lakefill (i.e., ambient sediment quality) is equal to or better than the No Effect Level of the Unconfined Fill Guidelines (Appendix B) then the fill material quality must not exceed the No Effect Level (Figure 2).

If sediment quality (ambient) exceeds the No Effect Level but meets the Lowest Effect Level of the Unconfined Fill Guidelines then the fill material quality must not exceed the Lowest Effect Level.

If the fill material quality exceeds the Lowest Effect Level, the fill does not qualify as Unconfined Fill.

Other Parameters

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[1] Calm period is normally considered to be the period from June through August when the normal climatic conditions do not generate any sustained high energy waves. This period may be extended on a case-specific basis if it can be demonstrated, based on climatic records (i.e., wind and wave data) (OMNR 1988), that the occurrence of significant waves greater than 0.5m will occur with an expected probability of <25%.

If ambient sediment quality in the vicinity of the lakefill is equal to or better than the Lowest Effect Level, then the fill material quality must not exceed the Lowest Effect Level (Figure 3).

If ambient sediment quality exceeds the Lowest Effect Level, then fill material quality must be equal to or better than ambient, provided that the quality of the fill material does not exceed lake background. Background levels are determined according to the procedure provided in the PSQGs (Persaud et al. 1993).

In addition to meeting the Site-Specific Suitability criteria, material to be considered for use as Unconfined Fill must also meet the following criteria

- The material must be free of substances that could form objectionable deposits. This would require visual screening of the material to ensure it is free of substances such as vegetation, wood, paper, plastic products, metal scraps, odoriferous and colour-imparting materials.
- The material must be free of substances that are acutely lethal to aquatic life (OMOE 1992).
- The material must not create water quality conditions that would impair the health and well-being of aquatic life and other normal water uses. This requires evaluation using the procedure described under the Receiving Water Simulation Test .
- The material must be free of substances that could result in significant bioaccumulation in aquatic organisms.

Receiving Water Simulation

Tests for bioaccumulation, and water quality impairment will be carried out by using a test which simulates the water column at the fill face, as described below.

The water column at the fill face will be simulated by placing one part of fill material to twenty parts of distilled water on a weight-to-weight basis and agitating the mixture for 24 hours. After a settling period of one hour, aliquots of the supernatant will be decanted and used in the following test:

The supernatant will be analyzed for the presence of bioaccumulative compounds in the mandatory list, i.e., PCBs and mercury (Table B-3), as well as others that may be required on a case specific basis where parameters in Appendix B (Table B-4) exceed the No Effect Level guideline in a bulk chemical analysis. The concentration of these substances in the supernatant must be below the Provincial Water Quality Objectives/Interim Objectives (PWQO/IO).

The supernatant will also be analyzed for the other parameters (Table B-1) that are known to be present in the material based on bulk chemical analysis. The concentrations of the substances (with the exception of mercury) must not exceed ten times the PWQOs/IOs (this assumes a 10:1 dilution in the near field of the dumping operation; if the dilution is less than 10:1, the appropriate factor applies). Concentrations of mercury must not exceed the PWQO in the supernatant because of its high bioaccumulative potential.

Only when all of the above criteria have been met is the material acceptable as Unconfined Fill.

4.3.3 Rationale - Chemical Effects

When contaminants in fill are lost to the aquatic environment they will either become dissolved in water or remain associated with particulate matter which will eventually settle to the bottom.

Contaminants in the water column, either in solution or associated with suspended particulate matter, can have a wide range of effects. These include exceedances of drinking water objectives (with potential human health implications), direct toxicological effects on aquatic biota, bioaccumulation of contaminants through the food chain with possible toxicological effects on predators, and restrictions on commercial management of fish or on sport fish consumption.

Most studies related to lakefilling have concluded that water quality effects are localized, with infrequent detection of nutrients, metals and organics above PWQOs. Neither acute nor chronic biological effects have been documented and, in any case, detecting such effects in the field would be a difficult task.

A PWQO is designed to protect the most sensitive water use whether it be for the protection of aquatic biota, recreation or other uses. In the vicinity of lakefills, the PWQOs are not routinely violated but are occasionally exceeded. Since acute biological effects in these areas have not been observed, it has been assumed that lakefilling has not had acute toxicological effects on pelagic biota (biota ranging throughout the water column). However, chronic effects may have occurred in localized areas near active filling where PWQOs have been exceeded.

Fill lost to the aquatic environment from a lakefill site is eventually deposited on the bottom. Most will be deposited in the vicinity of the lakefill, at least on a temporary basis. Studies (Jaagumagi and Persaud 1992) have found elevated levels of some contaminants in biota and sediment in the vicinity of lakefilling operations on the Toronto waterfront; however, it is often difficult to separate the effects of lakefilling from other point and non-point sources of contaminants.

There is little information on uptake of contaminants by biota in the vicinity of lakefills under construction. It can be reasonably assumed that, if the sediments lost during the filling process are contaminated, and there are no other significant sources of contaminants, then aquatic biota in areas adjacent to lakefilling will have higher contaminant body burdens than in areas not influenced by lost fill. Therefore, it is prudent to minimize the loss of fill, and to ensure that any fill lost is not contaminated.

4.4 Physical Effects

4.4.1 Turbidity Criteria

All reasonable measures will be taken during filling operations to minimize turbidity levels. Specific mitigative measures will be determined on a site-specific basis in consultation with Ministry staff, but will include the following general measures:

- Filling in areas exposed to wave action will occur only during a defined "calm" period. During other periods, filling will occur only in protected areas, not prone to wave attack.
- The exposed fill face will be restricted to a specific length, usually 15 metres. All other areas must be protected with erosion-resistant material to withstand, as a minimum, the annual storm event.
- All areas exposed to wave attack must be protected, prior to the end of the calm period, against the estimated 25-year storm significant wave but once confined fill has been placed in the core of the lakefill, then the Confined Fill criteria (i.e., the 100-year storm significant wave) will apply.

Where sensitive water uses are identified, turbidity levels must be within the specifications of the PWQO. Site monitoring may be required to ensure compliance with PWQOs. If violations occur, then the proponent will take corrective action immediately, according to the project's contingency plan, in which the proponent identifies essential controls and/or mitigative measures to be taken if violations occur. Such measures may include installations of silt curtains or filling only behind dikes constructed of erosion-resistant material.

4.4.2 Rationale - Turbidity

In extreme cases, turbidity has adverse effects on biota. The short-term levels of suspended sediment (which is one component of turbidity) required to adversely affect biota are higher than levels resulting from lakefilling. Localized levels of suspended solids above 25 mg/L (which is the generally accepted "no effect" level) may occur close to the active fill face; however, such levels are not expected beyond the immediate vicinity of the fill face.

At low levels, turbidity affects water uses such as bathing, industrial water uses and aesthetics. There are specific PWQOs to protect against adverse effects on these uses.

Studies indicate that turbidity increases due to lakefilling activities are usually difficult to discern over natural background levels, although violations of the PWQO have been documented. These studies have been carried out in Lake Ontario in the Toronto area where background turbidity levels can be high, obscuring increases from lakefilling. In areas where background turbidity levels are low, violations of the PWQO would be expected close to active lakefilling if loose soil is being dumped directly into the water.

4.4.3 Sedimentation Criteria

To minimize sediment losses, the mitigative measures outlined above to reduce turbidity will be required.

All sensitive water uses within the area where sedimentation is likely to occur will be protected. (The proponent must identify control measures prior to undertaking the project as well as remedial measures that will be taken if impacts do occur.)

4.4.4 Rationale - Sedimentation

Fill lost during the lakefilling process is likely to be deposited either along adjacent shorelines or offshore, and could affect navigation routes, water intakes and discharges, and aquatic habitat.

Deposition of fine-grained sediments and associated changes in benthic (bottom-dwelling biota) community structure have been documented in the vicinity of lakefills as a direct result of the loss of fill.

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Appendix A Legislative Requirements

A 1. Legislative Requirements

Prior to commencing any lakefilling project, the necessary permits and approvals will have to be obtained from the appropriate agencies. Depending upon site-specific conditions, a project may require a number of permits or approvals from various government agencies and levels of government, all of which have jurisdiction within the same area. For example, most large lakefill projects undertaken by the Province will require an Environmental Assessment under the Environmental Assessment Act.

Some projects can be exempted by demonstrating that they are undertaken in the public interest. Exempted projects will still have to identify potential effects of all aspects of the remediation project, as well as identifying mitigation measures, the consequences of not performing the project, etc. Lakefilling activities undertaken in accordance with these guidelines do not exempt the project from any other statutory prohibitions regarding the discharge of deleterious substances under federal or provincial legislation.

Various types of approval may also be required for work in streams and lakes. The following is a partial list of legislation and other documents that may apply in relation to lakefilling projects.

A 2. Federal Legislation

- *Canadian Environmental Assessment Act*
- *Canadian Environmental Protection Act*
- *Migratory Birds Convention Act, 1994*
- *Fisheries Act*
- *Navigable Waters Protection Act (NWPA)*
- *Great Lakes Water Quality Agreement*

A 3. PROVINCIAL LEGISLATION

- *Environmental Assessment Act*
- *Environmental Protection Act*
- *Ontario Water Resources Act*
- *Beds of Navigable Waters Act*
- *Public Lands Act*
- *Conservation Authorities Act*
- *Lakes and Rivers Improvement Act*
- *Planning Act*
- *Mining Act*

Appendix B Fill Quality Guidelines

Table B1: Confined Fill Guidelines Mandatory Parameter List

Parameter	Guideline
Arsenic	20 ug/g (ppm)
Cadmium	3 ug/g (ppm)
Chromium (total)	750 ug/g (ppm)
Copper	150 ug/g (ppm)
Lead	200 ug/g (ppm)
Mercury	10 ug/g (ppm)
Nickel	150 ug/g (ppm)
Zinc	600 ug/g (ppm)

Plus: Any elements or compounds which an examination of the history of origin of the material indicates are likely to be of concern.

In addition, material that may be considered for use as Unconfined Fill should also be analyzed for PCBs, Total Organic Carbon and Total Phosphorus. These analyses are not required if the material is being considered only as Confined Fill

Table B2: Confined Fill Guidelines Additional Parameter List

As listed in Table B-1 **Plus**

Any elements or compounds, which an examination of the history of origins of the material indicate, are likely to be of concern.

Parameter	CONFINED FILL GUIDELINES (ug/g)
Acenaphthene	15 ug/g
Acenaphthylene	100 ug/g
Acetone	3.5 ug/g
Aldrin	0.05 ug/g
Anthracene	28 ug/g
Antimony	13 ug/g
Arsenic	20 ug/g
Barium	750 ug/g
Benzene	0.24 ug/g
Benzo(a)anthracene	6.6 ug/g
Benzo(a)pyrene	1.2 ug/g
Benzo(b)fluoranthene	12 ug/g
Benzo(g,h,i)perylene	40 ug/g
Benzo(k)fluoranthene	12 ug/g
Beryllium	1.2 ug/g
Biphenyl, 1,1-	0.89 ug/g
Bis(2-chloroethyl)ether	0.66 ug/g
Bis(2-chloroisopropyl)ether	0.66 ug/g
Bis(2-ethylhexyl)phthalate	100 ug/g
Boron (available)	1.5 ug/g
Bromodichloromethane	0.12 ug/g
Bromoform	0.11 ug/g
Bromomethane	0.061 ug/g
Cadmium	3.0 ug/g
Carbon tetrachloride	0.10 ug/g

Parameter	CONFINED FILL GUIDELINES (ug/g)
Chlordane	0.29 ug/g
Chloroaniline, p-	1.3 ug/g
Chlorobenzene	2.4 ug/g
Chloroform	0.13 ug/g
Chlorophenol, 2-	0.1 ug/g
Chromium (Total)	750 ug/g
Chromium (VI)	8.0 ug/g
Chrysene	12 ug/g
Cobalt	40 ug/g
Copper	150 ug/g
Cyanide (free)	100 ug/g
Dibenzo(a,h)anthracene	1.2 ug/g
Dibromochloromethane	0.09 ug/g
Dichlorobenzene, 1,2- (o-DCB)	0.88 ug/g
Dichlorobenzene, 1,3- (m-DCB)	30 ug/g
Dichlorobenzene, 1,4- (p-DCB)	0.32 ug/g
Dichlorobenzidine, 3,3'-	1.3 ug/g
DDD	2.2 ug/g
DDE	1.6 ug/g
DDT	1.6 ug/g
Dichloroethane, 1,1-	3.0 ug/g
Dichloroethane, 1,2-	0.022 ug/g
Dichloroethylene, 1,1-	0.0024 ug/g
Dichloroethylene, cis-1,2-	2.3 ug/g
Dichloroethylene, trans-1,2-	4.1 ug/g
Dichlorophenol, 2,4-	0.3 ug/g
Dichloropropane, 1,2-	0.019 ug/g
Dichloropropene, 1,3-	0.0066 ug/g
Dieldrin	0.05 ug/g
Diethyl phthalate	0.71 ug/g

Parameter	CONFINED FILL GUIDELINES (ug/g)
Dimethyl phthalate	0.7 ug/g
Dimethylphenol, 2,4-	0.94 ug/g
Dinitrophenol, 2,4-	0.2 ug/g
Dinitrotoluene, 2,4-	0.66 ug/g
Dioxin/furan (ng TEQ/g soil)	0.01 ug/g
Endosulfan	0.18 ug/g
Endrin	0.05 ug/g
Ethylbenzene	0.28 ug/g
Ethylene dibromide	0.0056 ug/g
Fluoranthene	40 ug/g
Fluorene	340 ug/g
Heptachlor	0.084 ug/g
Heptachlor epoxide	0.06 ug/g
Hexachlorobenzene	0.46 ug/g
Hexachlorobutadiene	0.38 ug/g
Hexachlorocyclohexane, gamma	0.41 ug/g
Hexachloroethane	3.8 ug/g
Indeno(1,2,3-cd)pyrene	12 ug/g
Lead	200 ug/g
Mercury	10 ug/g
Methoxychlor	4.0 ug/g
Methyl ethyl ketone	0.27 ug/g
Methyl isobutyl ketone	0.48 ug/g
Methyl mercury	6.8 ug/g
Methyl tert butyl ether	5.7 ug/g
Methylene chloride	1.1 ug/g
Methylnaphthalene, 2-(*1-)	1.2 ug/g
Molybdenum	5.0 ug/g
Naphthalene	4.6 ug/g
Nickel	150 ug/g

Parameter	CONFINED FILL GUIDELINES (ug/g)
Pentachlorophenol	5.0 ug/g
Petroleum hydrocarbons (gas/diesel)	100 ug/g
Petroleum hydrocarbons (heavy oils)	1000 ug/g
Phenanthrene	40 ug/g
Phenol	40 ug/g
Polychlorinated biphenyls	0.5 ug/g
Pyrene	250 ug/g
Selenium	2.0 ug/g
Silver	20 ug/g
Styrene	1.2 ug/g
Tetrachloroethane, 1,1,1,2-	0.019 ug/g
Tetrachloroethane, 1,1,2,2-	0.01 ug/g
Tetrachloroethylene	0.45 ug/g
Thallium	4.1 ug/g
Toluene	2.1 ug/g
Trichlorobenzene, 1,2,4-	30 ug/g
Trichloroethane, 1,1,1-	26 ug/g
Trichloroethane, 1,1,2-	0.28 ug/g
Trichloroethylene	1.1 ug/g
Trichlorophenol, 2,4,5-	3 2 ug/g
Trichlorophenol 2,4,6-	0.66 ug/g
Vanadium	200 ug/g
Vinyl chloride	0.003 ug/g
Xylenes	25 ug/g
Zinc	600 ug/g
Electrical conductivity (mS/cm)	0.70 ug/g
Sodium adsorption ratio (SAR)	5.0 ug/g

Table B3: Unconfined Fill Guidelines Mandatory Parameter List

Parameter	No Effect Level	Lowest Effect Level
PCB	0.01 ug/g	0.07 ug/g
Arsenic	No data available	6 ug/g
Cadmium	No data available	0.6 ug/g
Chromium (total)	No data available	26 ug/g
Copper	No data available	16 ug/g
Lead	No data available	31 ug/g
Mercury	No data available	0.2 ug/g
Nickel	No data available	16 ug/g
Zinc	No data available	120 ug/g
Total Organic Carbon %	No data available	1 ug/g
Total Phosphorus	No data available	600 ug/g

Table B4: Unconfined Fill Guidelines Additional Parameters

Metals

Parameter	No Effect Level (ug/g)	Lowest Effect Level(ug/g)
Iron (%)	No data available	2 ug/g
Manganese	No data available	460 ug/g

Organochlorine Compounds

Parameter	No Effect Level (ug/g)	Lowest Effect Level(ug/g)
Aldrin	No data available	0.002 ug/g
BHC	No data available	0.003 ug/g
α-BHC	No data available	0.006 ug/g
β-BHC	No data available	0.005 ug/g
γ-BHC	0.0002	0.003 ug/g
Chlordane	0.005 ug/g	0.007 ug/g
DDT(total)	No data available	0.007 ug/g
op+pp-DDT	No data available	0.008 ug/g
pp-DDD	No data available	0.008 ug/g
pp-DDE	No data available	0.005 ug/g
Dieldrin	0.0006 ug/g	0.002 ug/g
Endrin	0.0005 ug/g	0.003 ug/g
HCB	0.01 ug/g	0.02 ug/g
Heptachlor	0.0003 ug/g	No data available
H epoxide	No data available	0.005 ug/g
Mirex	No data available	0.007 ug/g
PCB 1254	No data available	0.06 ug/g
PCB 1248	No data available	0.03 ug/g
PCB 1016	No data available	0.007 ug/g
PCB 1260	No data available	0.005 ug/g

Polycylic Aromatic Hydrocarbons

Parameter	No Effect Level (ug/g)	Lowest Effect Level(ug/g)
Anthracene	No data available	0.220 ug/g
Benz[a]anthracene	No data available	0.320 ug/g
Benzo[k]fluoranthene	No data available	0.240 ug/g
Benzo[a]pyrene	No data available	0.370 ug/g
Benzo[g,h,i]perylene	No data available	0.170 ug/g
Chrysene	No data available	0.340 ug/g
Dibenzo[a,h]anthracene	No data available	0.060 ug/g
Fluoranthene	No data available	0.750 ug/g
Fluorene	No data available	0.190 ug/g
Indeno[1,2,3-cd]pyrene	No data available	0.200 ug/g
Phenanthrene	No data available	0.560 ug/g
Pyrene	No data available	0.490 ug/g
PAH (total)	No data available	4 ug/g

Figure 1: Categorization of Fill for Lakefilling

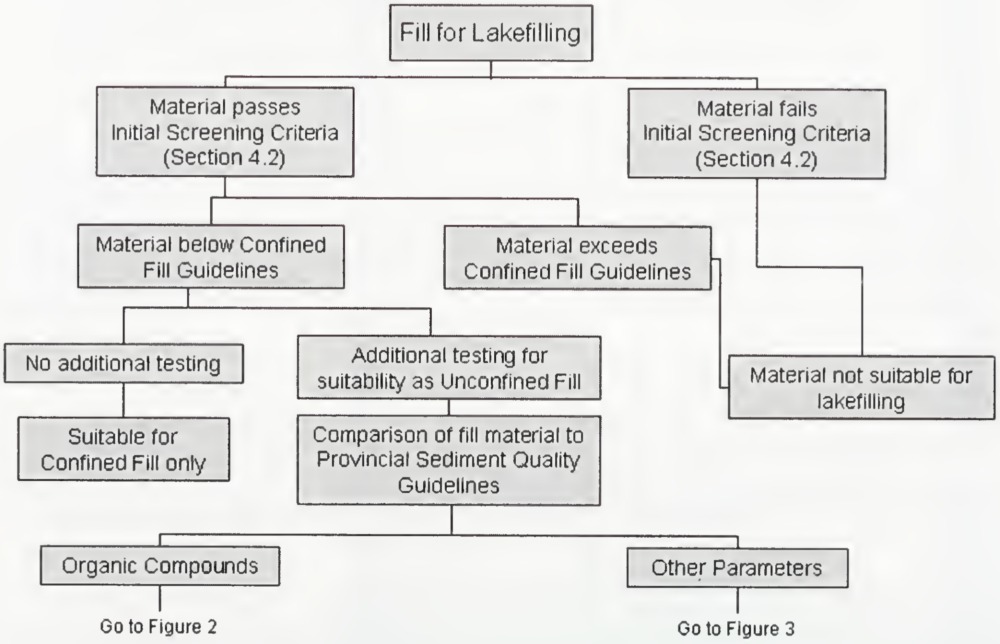

Fill for Lakefilling
Material passes Initial Screening Criteria (Section 4.2)
Material fails Initial Screening Criteria (Section 4.2)
Material below Confined Fill Guidelines
Material exceeds Confined Fill Guidelines
No additional testing
Additional testing for suitability as Unconfined Fill
Material not suitable for lakefilling
Suitable for Confined Fill only
Comparison of fill material to Provincial Sediment Quality Guidelines
Organic Compounds
Other Parameters
Go to Figure 2
Go to Figure 3

Figure 2: Site Specific Sediment Criteria for Organic Compounds

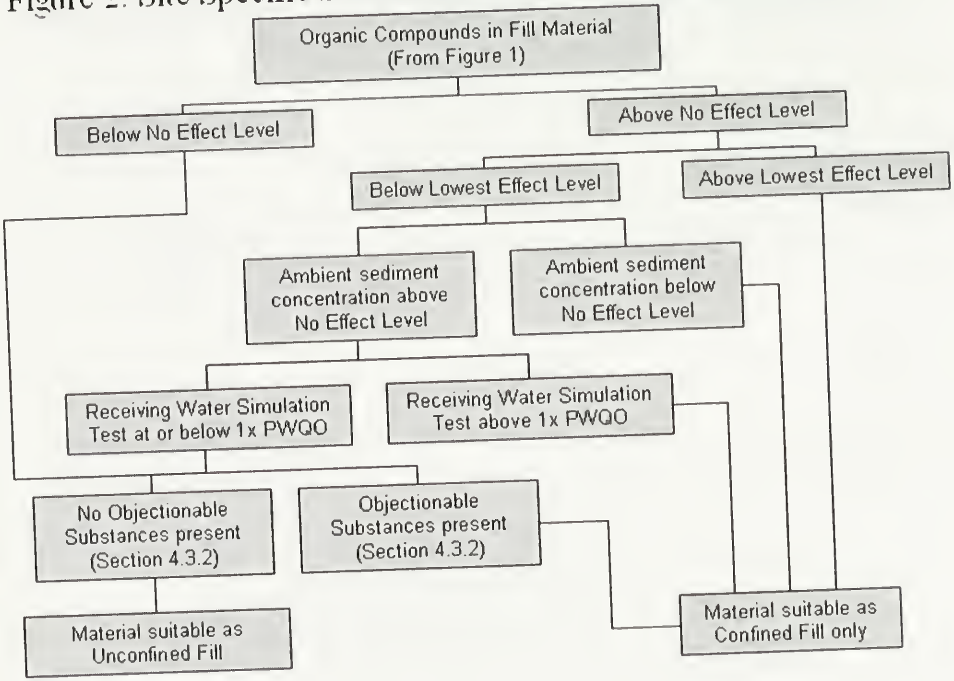
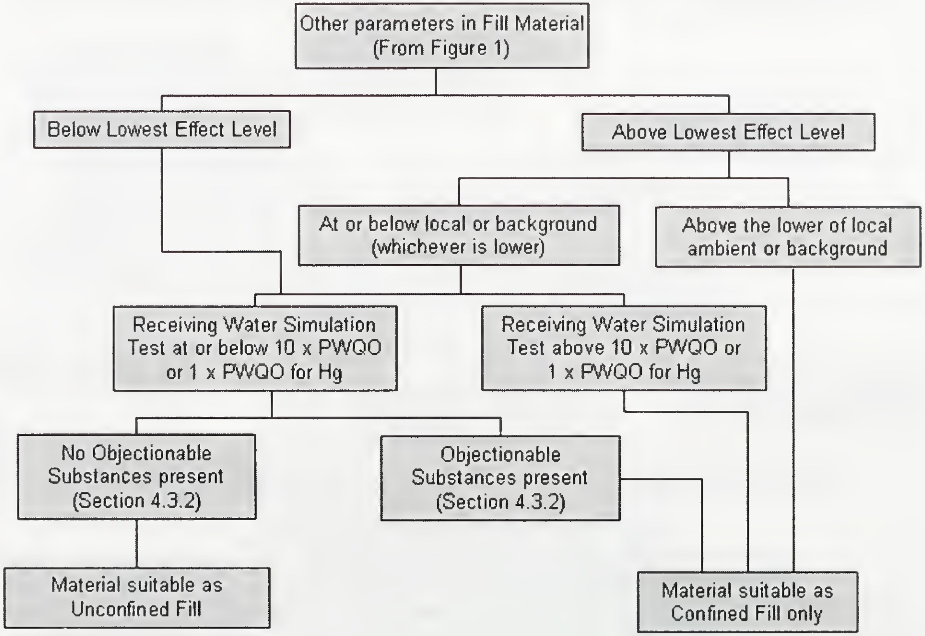

Organic Compounds in Fill Material (From Figure 1)
Below No Effect Level
Above No Effect Level
Below Lowest Effect Level
Above Lowest Effect Level
Ambient sediment concentration above No Effect Level
Ambient sediment concentration below No Effect Level
Receiving Water Simulation Test at or below 1x PWQO
Receiving Water Simulation Test above 1x PWQO
No Objectionable Substances present (Section 4.3.2)
Objectionable Substances present (Section 4.3.2)
Material suitable as Unconfined Fill
Material suitable as Confined Fill only

Figure 3: Site Specific Sediment Criteria for Organic Compounds


Other parameters in Fill Material (From Figure 1)
Below Lowest Effect Level
Above Lowest Effect Level
At or below local or background (whichever is lower)
Above the lower of local ambient or background
Receiving Water Simulation Test at or below 10 x PWQO or 1 x PWQO for Hg
Receiving Water Simulation Test above 10 x PWQO or 1 x PWQO for Hg
No Objectionable Substances present (Section 4.3.2)
Objectionable Substances present (Section 4.3.2)
Material suitable as Unconfined Fill
Material suitable as Confined Fill only